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APPLICATION FOR LETTERS PATENT

TITLE: APPARATUS AND METHOD FOR RECORDING DATA  
ONTO A PREDETERMINED RECORDING MEDIUM

INVENTORS: Teppei YOKOTA, Syuichi NAGANO,  
Toshiyuki KUNIMOTO

William S. Frommer  
Registration No. 25,506  
FROMMER LAWRENCE & HAUG LLP  
745 Fifth Avenue  
New York, New York 10151  
Tel. (212) 588-0800

004707" 2450543 101700

**APPARATUS AND METHOD FOR RECORDING DATA ONTO A  
PREDETERMINED RECORDING MEDIUM**

**BACKGROUND OF THE INVENTION**

The present invention relates to a recording apparatus and method for recording  
5 data played back from a variety of recording media onto a predetermined recording  
medium.

In recent years, a variety of different digital data formats for use in recording  
media have been developed, including formats for audio data, video data and computer  
data.

10 For example, as an optical-disc recording medium, the compact disc ("CD") has  
become very popular for use in a variety of applications. The CD is commonly used as a  
playback-only medium on which audio (music) data is pre-recorded as emboss pits. The  
format for such an audio (music) CD is commonly referred to as CD-Digital Audio ("CD-  
DA"). Recordable-type CDs, also known as CD-Recordables ("CD-R"s), and  
15 Rewritable-type CDs, known as CD-Rewritable ("CD-RW"s), have also been under  
development. CDs may also be used for storing computer data. A CD for storing such  
data is also called a CD-Read Only Memory ("CD-ROM").

In addition, an optical disc suitable for multimedia applications known as the  
Digital Versatile Disc or Digital Video Disc ("DVD"), is also being developed. The DVD  
20 has been proposed as a disc to be used in a variety of fields for storing data such as video  
data, audio data, and computer data.

The DVD is an optical disc with a diameter of 12 cm. The DVD is used for  
recording data at a track pitch of 0.8  $\mu$ m, which is equal to half the conventional CD  
track pitch of 1.6  $\mu$ m. The wavelength of a semiconductor laser for reading a DVD is  
25 650 nm as compared to 780 nm for reading a CD. In addition, an Eight-to-Fourteen  
Modulation ("EFM") technique adopted in the CD is improved to implement a high  
recording density equivalent to about 4 Gbyte per surface for a DVD.

A multi-layer disc having two recording layers conforming to such DVD  
specifications is also under development. DVDs also include DVD-ROMs, DVD-RWs  
30 (Rewritable), and DVD-Rs (Recordable), which are analogous to their CD counterparts.

DVD-RWs and DVD-Rs allow for recording and playback operations utilizing a phase change technique.

The Mini Disc ("MD"), which may be a magnetic disc or a magneto-optical disc having a diameter of 64 mm accommodated in a cartridge, is another medium for  
5 recording and playing back data.

The MD may be a playback-only optical disc on which audio (music) data is pre-recorded as emboss pits (similar to a music CD, i.e., a CD-DA). Such an MD is commonly referred to as a pre-mastered disc or, to be more specific, a pre-mastered MD-DA (Digital Audio). The MD may also be a recordable magneto-optical disc onto which  
10 audio (music) data may be recorded and from which the data may be played back by adopting a magnetic-field modulation technique. Such MDs are referred to as recordable MD-DAs.

The magneto-optical disc known as MD-DATA may be used for recording various kinds of data such that the disc can be used in apparatuses such as a computer.  
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It is noted that discs adopting the CD and DVD systems may be referred to merely as discs, while discs adopting the MD system are referred to as cartridge-discs.

Aside from the variety of disc-shaped recording media described above, small-size memory cards for mounting a non-volatile memory, such as a flash memory, have been in development as a recording device.

Various kinds of information may be written into and read out from such a  
20 memory card using a dedicated drive unit or equipment, such as an audio/video apparatus, or an information apparatus in which a drive unit is embedded. In a digital still camera including such an embedded drive unit, for example, data of a photographed still image is stored in a memory card. Devices for recording information such as  
25 computer data, video (e.g., still- or moving-picture) data, and audio (music) data on a memory card are also being developed.

One advantage of the memory card is that it does not require complex mechanical configurations, such as a rotation mechanism, a tape-traveling mechanism, a head mechanism, and a servo system; as is the case with systems for driving a disc-  
30 shaped recording medium or a tape recording medium. In addition, the memory card is superior in write and read speeds. These characteristics of a memory card provide for a

low-cost, small power consumption, small-sized, and small-thickness storage medium. Furthermore, it is easy to mount a memory card onto a variety of units. These factors promote the development of a semiconductor memory card as a very useful memory storage medium.

5           As recordable (including rewritable) media for recording various kinds of digital data are becoming more popular (e.g., CD-R, CD-RW, DVD-R, DVD-RW, etc.), wherein a copy operation does not significantly degrade the quality of data, there is a need to protect copyrighted material from being freely copied onto such recordable media.

10           Completely forbidding any copying is impractical because high capacity storage media are often used for recording a private copy of (or "backing up") data for safe-keeping.

15           In order to solve the problem described above in an MD system for recording and playing back audio data, a digital copy of digital audio data recorded on a CD-DA is permitted only for a first generation. This permission of a copy for the first generation is implemented by a policy called a Serial Copy Management System ("SCMS").

20           However, the existence of such a variety of recording media described above, the existence of data compressing technologies of the variety of recording media, and different actual applications result in an unclear situation. In this situation, a boundary between permitting and forbidding a copy operation cannot help varying from medium to medium, from technology to technology and from application to application. For this reason, it is practically improper to uniformly regulate operations to copy data among the variety of recording media.

25           For example, the SCMS for permitting a digital copy only for the first generation can not be said to be suitable for all cases. This is because, in some cases, a policy to completely forbid a copy operation is considered to be desirable while, in other cases, a policy to permit copies of up to a second generation or even a further generation is deemed proper.

30           In addition, in recent years, popularization and improvement of data communication technologies, such as the Internet, and improvement of data compression technologies have also given rise to problems in copyright protection. High-quality data compression allows data to be presented to an unspecified number of users by way of the

5 In response, for discs such as the CD-DA, a digital watermark technology known simply as a watermark technology is being developed. This technology is a technology for including a watermark in data, wherein the watermark is erased in a process such as compression processing. Thus, by prohibiting an operation to record data when the watermark is not detected by a recording apparatus, compressing and copying  
10 of copyrighted data can be prevented. For example, it is therefore possible to prevent a copyright from being infringed by downloading and recording copyrighted data onto a disc, such as a CD-ROM, and illegally selling such a disc. However, a circuit for detecting a watermark must be provided in the recording apparatus. In addition, many discs, such as CD-DAs presently in circulation, do not necessarily have a watermark.  
15 Thus, the watermark technology is not a practical solution.

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## **OBJECTS AND SUMMARY OF THE INVENTION**

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part be apparent from the specification and the drawings.

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judgment as to whether the first recording medium is a recording medium allowing a dubbing operation or a recording medium prohibiting a dubbing operation, and control means capable of inhibiting an operation carried out by the recording means to record information played back from the first recording medium into the second recording medium when the result of a judgment formed by the judgment means indicates that the

According to a second aspect of the present invention, a recording and playback apparatus includes playback means capable of playing back information from a first recording medium, recording means capable of recording information played back from the first recording medium into a second recording medium, judgment means for forming a judgment as to whether the first recording medium is a recording medium allowing a dubbing operation or a recording medium prohibiting a dubbing operation, and control means capable of inhibiting an operation carried out by the recording means to record information played back from the first recording medium into the second recording medium when the result of a judgment formed by the judgment means indicates that the

According to a third aspect of the present invention, a recording method includes a judgment step of forming a judgment as to whether a first recording medium is a recording medium allowing a dubbing operation or a recording medium prohibiting a dubbing operation, a recording step of recording information played back from the first recording medium into a second recording medium when the result of a judgment formed at the judgment step indicates that the first recording medium is a recording medium allowing a dubbing operation, and a recording inhibit step of inhibiting an operation to record information played back from the first recording medium into the second recording medium when the result of a judgment formed at the judgment step indicates that the first recording medium is a recording medium prohibiting a dubbing operation.

In the recording apparatus, the recording and playback apparatus and the recording method, the first recording medium may have a shape like a disc whereas the second recording medium may be a non-volatile memory.

The judgment as to whether a first recording medium is a recording medium allowing a dubbing operation or a recording medium prohibiting a dubbing operation

may be based on information conveyed by a light reflected from the first recording medium or predetermined identification information recorded on the first recording medium.

5 A recording medium allowing a dubbing operation may be a playback-only recording medium while a recording medium prohibiting a dubbing operation is a recording medium onto which data can be recorded.

10 A recording medium allowing a dubbing operation may also be a playback-only recording medium on which whole information is recorded as emboss pits while a recording medium prohibiting a dubbing operation is a recording medium other than the recording medium allowing a dubbing operation.

15 A recording medium allowing a dubbing operation may also be a playback-only recording medium on which whole information serving as management information and audio data is recorded as emboss pits while a recording medium prohibiting a dubbing operation is a recording medium other than the recording medium allowing a dubbing operation.

20 By controlling permission and prohibition to record (or dub or copy) data onto the second recording medium on the basis of an outcome of the judgment as to whether a first recording medium is a recording medium allowing a dubbing operation or a recording medium prohibiting a dubbing operation, as described above, it is possible to implement data copy management according to the type of the first recording medium.

25 The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combination(s) of elements and arrangement of parts that are adapted to effect such steps, all as exemplified in the following detailed disclosure, and the scope of the invention will be indicated in the claims.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

For a more complete understanding of the invention, reference is made to the following description and accompanying drawing(s), in which:

30 Fig. 1 is a diagram showing an external appearance of a recording and playback apparatus in accordance with an embodiment of the present invention;

Fig. 12 is a table showing whether to permit or prohibit an operation to record data from various types of discs onto a memory card in accordance with an embodiment of the present invention.

A recording and playback apparatus in accordance with an embodiment of the present invention is capable of recording and playing back data into and from a variety of recording media, such as discs adopting the CD and DVD systems, cartridge-discs



In accordance with an embodiment, various kinds of data such as audio data, moving-picture data, still-picture video data, computer data, and text data may be recorded and played back. For illustrative purposes, the description of the recording and  
5 playing back of data will be that of audio data.

The external appearance of a recording and playback apparatus 10 according to a preferred embodiment is shown in Fig. 1.

Recording and playback apparatus 10 comprises a disc insertion unit 13, a memory-card insertion unit 14, and a cartridge-disc insertion unit 15.

When the user opens a front cover of cartridge-disc insertion unit 15, an insertion opening 15a is exposed to the user, as shown in Fig. 2A. The user may then insert a cartridge-disc 91 (e.g., MD) into insertion opening 15a. Cartridge-disc 91 may also be a pre-mastered MD-DA, a recordable MD-DA, an MD-DATA or the like.

Referring back to Fig. 1, recording and playback apparatus 10 also has a display unit 12 implemented by a liquid-crystal panel for displaying data, such as information on recording and playback operations and time information. The information on recording and playback operations may include operating modes of a recording medium undergoing a recording or playback operation. Display unit 12 may also display information added

to data (e.g., the title and/or artist of a song) being played back, a guide message explaining an operation, and/or a menu screen for playback and edit operations, and the like.

Display unit 12 includes a touch panel 17 typically used for displaying operation keys accompanying a displayed menu screen. The user may touch a displayed operation key (not shown) displayed on touch panel 17 to carry out an input operation.

A variety of operators 16 are also included on recording and playback apparatus 10, as shown in Fig. 1. Operators 16 may include an operation key for requesting a recording or playback operation, an operation key for inserting or ejecting a recording medium, a power-supply operation key, an operation dial for adjusting the volume of a sound and a jog dial applicable to a variety of operations.

Recording and playback apparatus 10 may also include a variety of terminals (not shown) for connecting to various kinds of equipment. For example, recording and playback apparatus 10 may be provided with a headphone terminal, a microphone input terminal, a line input terminal, a line output terminal and a digital audio input/output terminal for inputting and outputting (using, e.g., an optical cable) audio signals. In addition, by providing an IEEE1394 connector, a USB connector, an SCSI connector, a serial port, an RS232C connector, and the like, various kinds of data can be exchanged with external equipment.

#### External Appearance of a Memory Card

An external appearance of memory card 1 is shown in Fig. 3.

As shown in Fig. 3, memory card 1 includes an external planar card case for encasing a semiconductor memory device having a predetermined storage capacity. In a preferred embodiment, a flash memory is used as the semiconductor memory device. The internal components of memory card 1 according to an embodiment of the invention will be described in further detail below with reference to Fig. 5.

Fig. 3 shows a top view, a front view, a side view and a bottom view of a card case which may be created by a plastic mold. As shown in Fig. 3, dimensions of the card case may be a width W11 (of 60 mm), a width W12 (of 20 mm), and a width W13 (of 2.8 mm).

A terminal unit 2 with 10 electrodes may be spread from the lower portion of the front surface of the card case to a side of the bottom of the case for reading data out of and writing data into memory card 1 therethrough.

A cut 3 is provided on the left upper part of the card case in the planar direction.

- 5 Cut 3 prevents memory card 1 from being mounted on a mounting and dismounting mechanism of apparatus 10 with an incorrect orientation.

A label sticking surface 4 is stretched from the top of the card case to the bottom thereof for placing a user label.

- 10 In addition, a slide switch 5 for preventing incorrect erasure of data stored in memory card 1 is provided on the bottom of the card case.

- Memory card 1 may include a flash memory with a storage capacity of 4, 8, 16, 32, 64 or 128 megabytes ("MB"). A so-called File Allocation Table ("FAT") system may be used as a file system for implementing operations to record and play back data. In accordance with an embodiment of the invention, a write speed is in the range of 1,500  
15 Kbyte/sec to 330 Kbyte/sec; a read speed is 2.45 Mbyte/sec; a write-operation unit is 512 bytes; the size of an erased block is 8 KB or 16 KB; the voltage Vcc of the power supply is in the range of 2.7 V to 3.6 V; and the frequency of a serial clock signal SCLK is up to 20 MHz.

- 20 It is noted that the shape of memory card 1 to be mounted on recording and playback apparatus 10 may be different from the one described above. For example, memory card 1 may have the size and shape of a business card.

The storage capacity, the application, and the type of stored data may also vary from card to card.

25 Internal Configuration of the Recording and Playback Apparatus

- Fig. 4 is a diagram showing the internal configuration of recording and playback apparatus 10 according to an embodiment of the invention. For illustrative purposes, operations for audio data is illustrated, and components, including a system for processing information, such as video data, and an interface with external equipment, are  
30 excluded for simplicity.

In accordance with an embodiment of the invention, the operation of recording

and playback apparatus 10 is controlled by a system controller 20 which may be implemented by a microcomputer.

System controller 20 executes an internal operating program to drive necessary components to carry out required operations in accordance with information on the operations received from the variety of operators 16 (also shown in Fig. 1) and information on the operations received from touch panel 17.

System controller 20 also displays various kinds of information and operation keys for touch panel 17 on display unit 12 in accordance with the operating state.

Fig. 4 is a diagram showing components in recording and playback apparatus 10 for outputting audio data from a variety of sources to speakers 11L and 11R in accordance with an embodiment of the invention. The sources of the audio data output to speakers 11L and 11R include an external input, an AM/FM radio broadcast, disc 90 (which may be a CD or a DVD), cartridge-disc 91 (e.g., an MD), and memory card 1.

A terminal 21 is a terminal for inputting digital or analog audio data from an external apparatus. External data input through terminal 21 is amplified and subjected to processes such as filtering in an input-signal processing unit 22. If terminal 21 serves as a terminal for inputting an analog audio signal, the input analog audio signal is converted into digital data in an Analog-to-Digital ("A/D") conversion process.

External input data  $S_{in}$  generated by input-signal processing unit 22 is supplied to a terminal of a source select unit 28.

An AM/FM tuner 24 receives and demodulates an AM or FM radio broadcast extracted from a wave received by an antenna 23 to obtain a broadcast audio signal.

The demodulated broadcast audio signal is converted in an A/D conversion process into digital data. The broadcast audio data  $S_{tu}$  generated by AM/FM tuner 24 is supplied to an input terminal of source select unit 28.

It is noted that selection of a station frequency by AM/FM tuner 24 may be controlled by system controller 20 in accordance with an operation of operators 16 and/or operation keys on touch panel 17 by the user.

A disc recording and playback unit 25 for playing back and recording data from and into disc 90 as controlled by system controller 20 will be described in further detail below with reference to Fig. 6.

Playback data Sd played back from disc 90 by disc recording and playback unit 25 is supplied to an input terminal of source select unit 28.

A cartridge-disc recording and playback unit 26 for playing back and recording data from and into cartridge-disc 91, which may be an MD mounted through cartridge-disc insertion unit 15 shown in Fig. 1 is similarly controlled by system controller 20.

Playback data Smd played back from cartridge-disc 91 by cartridge-disc recording and playback unit 26 is supplied to an input terminal of source select unit 28.

A memory-card recording and playback unit 27 is included for playing back and recording data from and into memory card 1 mounted through memory-card insertion unit 14 shown in Fig. 1. The recording and playback operations are also controlled by system controller 20.

Memory-card recording and playback unit 27 will be described in further detail below with reference to Fig. 5.

Playback data Sms played back from memory card 1 by memory-card recording and playback unit 27 is supplied to an input terminal of source select unit 28.

Source select unit 28 selects an input terminal in accordance with control executed by system controller 20. In this way, digital audio data generated by a source selected by the user is supplied to an audio-signal processing unit 30.

Audio-signal processing unit 30 includes a Digital Signal Processor ("DSP"). Filtering, adjustment of the sound quality, and adjustment of the volume of the digital audio data are controlled by system controller 20.

The digital audio data is converted in a Digital-to-Analog ("D/A") conversion process into an analog audio signal after processing, and supplied to a power amplifier 31.

Power amplifier 31 amplifies the analog audio signal and supplies the amplified signal to speakers 11 as an output sound.

The operations carried out by the components of apparatus 10 as described above allow the user to select an external input, an AM/FM broadcast, disc 90, cartridge-disc 91, or memory card 1 as a sound source and listen to an audio output therefrom (such as a piece of music).

Audio data selected by source select unit 28 is supplied to a recording select unit

29 as data Srec for recording.

Recording select unit 29 selects a connection terminal in accordance with control executed by system controller 20. The data Srec to be recorded is supplied to either of disc recording and playback unit 25, cartridge-disc recording and playback unit 26, or memory-card recording and playback unit 27.

The to-be-recorded data Srec supplied to disc recording and playback unit 25, cartridge-disc recording and playback unit 26, or memory-card recording and playback unit 27 may be recorded onto disc 90, such as a CD-RW or a DVD-R, cartridge-disc 91, such as a recordable MD-DA or an MD-DATA, or memory card 1 as audio data.

In such a configuration, the user is able to record (or to dub) audio data generated by a selected source into one of the recording media.

Thus, with the configuration described above, one of the external input data Sin, the broadcast audio data Stu, the playback data Smd, and the playback data Sms may be recorded onto disc 90, cartridge-disc 91, or memory card 1.

As will be described in detail below, however, an operation to record the playback data Sd reproduced from disc 90 onto memory card 1 may be permitted only if disc 90 has a CD layer of a CD-DA or a Super Audio CD ("SACD") in accordance with an embodiment of the invention. Similarly, an operation to record the playback data Smd reproduced from cartridge-disc 91 onto memory card 1 may be permitted only if cartridge-disc 91 is a pre-mastered MD-DA.

An operation to record playback data Sd or Smd reproduced from disc 90 or cartridge-disc 91 not included in the specific categories described above, the external input data Sin, and the broadcast audio data Stu may be blocked by system controller 20 from memory-card recording and playback unit 27.

In addition, in source select unit 28 and recording select unit 29, signals are transferred at a digital-data stage and the data Srec to be recorded is supplied to memory-card recording and playback unit 27 or another recording and playback unit as digital data. Although only restrictions on copying digital data into memory card 1 has been described so far, it is noted that signal routes for supplying audio signals to disc recording and playback unit 25, cartridge-disc recording and playback unit 26, and memory-card recording and playback unit 27 as signals to be recorded can also be provided with

If an analog audio signal is transferred, that is, if the analog audio signal is subjected to an A/D conversion process before being recorded by memory-card recording and playback unit 27 or another recording/playback unit, a recording restriction may not be required in memory-card recording and playback unit 27 or the other recording/playback unit because, among other reasons, a similar effect may be accomplished by controlling (restricting) the A/D conversion process.

As shown in Fig. 5, memory-card recording and playback unit 27 records and plays back information such as digital audio data into and from memory card 1 on which a flash memory 42, a security block 52, and an access/control circuit (not shown) for flash memory 42 are mounted. It is noted that memory-card recording and playback unit 27 or a system for recording and playing back data into and from memory card 1 is also capable of recording and playing back other kinds of data, such as moving-picture data and still-picture data.

Memory card 1 may or may not include a security block 52. Security block 52 is a component for carrying out authentication or encryption for protecting copyrighted data. Thus, in a memory card used in an application requiring neither authentication nor encryption, security block 52 is not needed. An example of an application requiring neither authentication nor encryption is an application to record an audio signal such as voice data which does not need copyright protection as may be the case with conference voice recordings. For illustrative purposes, security block 52 is included.

Controller 102 exchanges a variety of control signals with system controller 20 and controls operations to record and play back data into and from memory card 1 in accordance with a command issued by system controller 20.

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5           Input audio data is encoded at a high efficiency by encoder/decoder 104 and encrypted by security block 103, as described above, before being supplied to controller 102.

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5 As another alternative, in a recording operation, the encryption process may be carried out twice, that is, once in security block 103 and another one in security block 52. In a playback operation, security block 52 and security block 103 may perform decryption processes opposite to the encryption processes carried out in the recording operation.

In addition to the encryption and decryption functions, security block 103 and security block 52 may each have an authentication function. With memory card 1 mounted on memory-card recording and playback unit 27, authentication data may be exchanged between security block 103 and security block 52. The exchanged authentication data is used for forming a judgment as to whether the authentication is valid or not (“OK” or “NG”). In the case of an invalid (“NG”) authentication result, memory-card recording and playback unit 27 may prohibit data to be recorded into or played back from memory card 1.

In memory-card recording and playback unit 27, controller 102 forms a  
30 judgment as to whether or not the second authentication data has been properly generated  
for the first authentication data, that is, a judgment as to whether the authentication is

As will be described in detail later, when the user issues a command to record playback data Sd or Smd reproduced from disc 90 or cartridge-disc 91 by disc recording and playback unit 25 or cartridge-disc recording and playback unit 26 onto memory card 1, system controller 20 forms a judgment as to whether the requested recording operation is permitted or prohibited in accordance with the type of disc 90 or cartridge-disc 91, notifying controller 102 of the outcome of the judgment.

Next, the configuration of disc recording and playback unit 25 is explained with reference to Fig. 6.

Disc 90, which can be a CD or a DVD, is mounted on a turn table 207 driven to rotation by a spindle motor 206 at a Constant Linear Velocity (“CLV”) or a Constant Angular Velocity (“CAV”) in a recording or playback operation.

Pickup 201 includes an objective lens 202, a double-shaft mechanism 203, a semiconductor laser diode 204, a detector 205 for receiving a reflected light from optical disc 90, and an optical system (not shown) serving as paths for a light emitted by semiconductor laser diode 204 and a light reflected by optical disc 90.

Normally, in order to make pickup 201 compatible with a CD-type disc, a laser light with a center wavelength of 780 nm is emitted and objective lens 202 with an NA of 0.45 is employed. By making pickup 201 compatible with a DVD-type disc, there would

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5           It is noted that the focus-error signal FE and the mirror signal MR are supplied to controller 210 to be used in processing to determine the type of disc 90, as will be described in further detail below.

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In a recording operation with disc recording and playback unit 25 selected by recording select unit 29, data Srec to be recorded is input through interface unit 213 and supplied to encoder/decoder 212 by way of data buffer 220.

Encoder/decoder 212 adds error correction codes to the to-be-recorded data Srec received from data buffer 220 and carries out processing such as the EFM-plus modulation to encode the data Srec. The encoded data Srec to be recorded is subjected to processes, such as pulse processing and equalization for recording in recorded-signal processing unit 221 before being supplied to laser driver 218. Laser driver 218 drives semiconductor laser diode 204 to emit a laser beam according to the data Srec to be recorded, recording the data Srec onto disc 90. Servo processor 214 executes various kinds of servo control. In particular, servo processor 214 carries out processing such as a focus-servo operation, a focus-search operation, a tracking-servo operation, a tracking-jump/access operation, a sled-servo operation, and a spindle-servo operation in accordance with commands issued by controller 210.

In a focus-search operation, the so-called S-curve of the focus-error signal FE is detected by forcibly moving objective lens 202 along a path between a position farthest from disc 90 and a position closest to disc 90 for a focus-servo lead-in. That is to say, the focus-error signal FE is observed as an S-curve with objective lens 202 being placed in a narrow range over a point serving as an in-focus position for a recording layer of disc 90. By turning on the focus servo in a linear range of the S-curve, a focus-search lead-in is possible. Thus, the focus-search operation is carried out for such a focus-servo lead-in. In a focus-search operation, servo processor 214 applies a drive signal for the focus-search operation to a double-shaft driver 216 to flow a driving current through a focusing coil employed in double-shaft mechanism 203. As a result, objective lens 202 is moved.

In the case of a track jump or an access, double-shaft mechanism 203 moves objective lens 202 in the radial direction of disc 90 and sled mechanism 208 moves pickup 201 also in the radial direction of disc 90. A tracking drive signal and a sled drive signal for moving objective lens 202 and pickup 201 as described above are applied by servo processor 214 to double-shaft driver 216 and the sled driver 215, respectively. As a result, the movements in the tracking directions driven by double-shaft mechanism 203 and sled mechanism 208 are accomplished.

In addition, servo processor 214 carries out servo operations by generating a variety of servo drive signals such as focus, tracking, sled, and spindle signals, from signals such as the focus-error signal FE and the tracking-error signal TE received from RF amplifier 209 and a spindle-error signal SPE received from encoder/decoder 212 or controller 210.

A focus drive signal and a tracking drive signal are generated in accordance with the focus-error signal FE and the tracking-error signal TE, respectively, and supplied to double-shaft driver 216. Double-shaft driver 216 flows driving currents based on the focus drive signal and the tracking drive signal, respectively, to a focusing coil and a tracking coil of two-shaft mechanism 203 in order to move objective lens 202. In this way, a tracking servo loop and a focusing servo loop are formed by pickup 201, RF amplifier 209, servo processor 214, and double-shaft driver 216.

In addition, servo processor 214 supplies a spindle drive signal generated in accordance with the spindle-error signal SPE to spindle-motor driver 217. Spindle-motor driver 217 then applies a 3-phase driving signal to spindle motor 206 in accordance with the spindle drive signal in order to rotate spindle motor 206 at a CLV or a CAV.

Servo processor 214 also outputs a spindle drive signal in accordance with a spindle kick/brake control signal received from controller 210 to spindle-motor driver 217 in order to carry out operations such as starting or halting the rotation of spindle motor 206.

Servo processor 214 also generates a sled drive signal based on a sled error signal obtained as a low-region component of the tracking-error signal TE and supplies the sled drive signal to sled driver 215. Sled driver 215 drives sled mechanism 208 in accordance with the sled drive signal. In this way, pickup 201 is slid properly.

#### Variety of Disc Structures

As described before, disc recording and playback unit 25 is capable of handling disc 90 of CD or DVD type. The structure of recording layers of disc 90 with CD or DVD type is explained as follows.

Recording media, such as disc 90, are classified by recording-layer count into 2 main categories, namely, a single-layer disc and a multi-layer disc. To be more specific, a

disc with 1 created recording layer is referred to as a single-layer disc while a disc with 2 or more created recording layers is referred to as a multi-layer disc where a recording layer is defined as a layer on which pits representing recorded data are created.

In addition to the classification of recording media based on the number of recording layers into a single-layer disc and a multi-layer disc as described above, there is also categorization of recording media based on the formation position of the recording layer, that is, the position of the recording layer in the thickness direction of the disc. The categorization is based on a difference between a data recording layer based on the CD system and a data recording layer based on the DVD system.

Since there are differences in recording-layer count and recording-layer formation position as described above, the layer structure of disc 90 may be classified into 4 main categories, as shown in Figs. 7A through 7D.

It should be noted that the disc diameter may be 8 cm or 12 cm for any disc. The surface of a disc is divided into 3 areas, namely, beginning from the inner circumference, a lead-in area, a data area, and a lead-out area.

A maximum diameter for a position to start the lead-in area may be 45.2 mm and a maximum diameter for a position to start the data area may be 48 mm.

It should be noted that, in the following description, data conforming to the CD system is referred to as CD data and a recording layer for recording CD data is referred to as a CD layer.

CD data may have a data format adopted in CD-DA. CD data is data obtained as a result of modulation of a 16-bit digital audio signal based on the EFM system wherein the 16-bit digital audio signal is samples resulting from sampling at a frequency of 44.1 KHz.

DVD data, which has a quality higher than CD data, conforms to a data format that is used for recording a 1-bit digital audio signal obtained as a result of

modulation at a very high sampling frequency of 2.842 MHz, which is 16 times the 44.1 KHz sampling frequency for CD data. Data having the format conforming to the DVD system is referred to as Hi-Definition ("HD") data and a recording layer for recording HD data is referred to as an HD layer.

Differences between CD data and HD data are as follows.



The frequency band of CD data is 5 to 20 KHz while HD data has a broad frequency range from the DC component to 100 KHz.

CD data implements a dynamic range of 98 dB over the entire audio band while HD data is capable of implementing a 120-dB frequency range over the entire audio band.

The minimum pit length of data recorded on a CD layer is 0.83  $\mu$ m while the minimum pit length of data recorded on an HD layer is 0.4  $\mu$ m.

The track pitch of a CD layer is 1.6  $\mu$ m while the track pitch of an HD layer is 0.74  $\mu$ m.

The read laser wavelength for a CD layer is 780 nm while that of an HD layer is reduced to 650 nm. As described above, CD data can also be played back at a wavelength of 650 nm, except for a disc dependent on the wavelength, such as a CD-R.

Furthermore, in the case of a CD layer, the lens NA of an optical head is 0.45 while that of an HD layer is 0.6. For NA = 0.6, however, the optical head is also capable of dealing with a CD layer.

As described above, by merely changing the minimum pit length, the track pitch, the lens numerical aperture NA and the laser wavelength, the storage capacity can be increased from 780 MB for data stored on a CD layer to a large value of 4.7 Gigabytes ("GB") for data stored on an HD layer.

4 types of discs having layers for recording CD data and/or HD data with a single-layer structure or a multi-layer structure include a single-plate disc, a single-layer HD disc, a hybrid disc, and a multi-layer HD disc.

#### Single-Plate Discs

Single-plate discs include the CD-DA, the CD-R, the CD-ROM, and the CD-RW.

As shown in Fig. 7A, a single-plate disc includes a recording layer L that is created at a position separated away from a disc surface Z2 by a distance of about 1.2 mm, that is, at a position in close proximity to a level plane Z1. Disc surface Z2 is a laser incidence surface of the disc.

Recording layer L is used as the CD layer for recording CD data.



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## Multi-Layer HD Discs

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Figs. 8A through 8D are diagrams showing a case in which a single-plate disc is mounted on the disc recording and playback unit 25. In this case, objective lens 202 is moved from a bottom position shown in Fig. 8A to a top position shown in Fig. 8D. The range between the bottom position and the top position is a focus search range over which objective lens 202 is moved at a predetermined speed.

It is noted that a beam reflected by disc surface Z2 is observed as a mirror signal MR because the gain of RF amplifier 209 is set at a high value during a focus-search operation.

Thus, when objective lens 202 is moved from the bottom position shown in Fig. 8A to the top position shown in Fig. 8D, a time to the in-focus state with respect to recording layer L, shown in Fig. 8C, is measured with the timing of reflection by disc surface Z2 of Fig. 8B taken as a reference. Since the time to the in-focus state with respect to recording layer L and the number of times the in-focus state is reached vary in dependence on the layer structure shown in Figs. 7A through 7D, the type of disc 90 can be identified.

Fig. 9A is a diagram showing a case in which disc 90 is a single-plate disc.

Fig. 9B is a diagram showing a case in which disc 90 is a single-layer HD disc.

In this case, recording layer L exists in about the middle of disc 90 in the thickness direction. Thus, after a time  $t_2$  lapses from when the mirror signal MR is detected, at a point of time an in-focus state with respect to disc surface Z2 of disc 90 is reached, an S-curve and a mirror signal MR are detected. Time  $t_2$  has a length of about half the length of time  $t_1$ .

Fig. 9C is a diagram showing a case in which disc 90 is a hybrid disc. In this case, first recording layer L1 exists in about the middle of disc 90 in the thickness direction. On the other hand, second recording layer L2 exists at a position in close proximity to level plane Z1. Thus, after time  $t_2$  lapses from when the mirror signal MR is detected, at a point of time an in-focus state with respect to disc surface Z2 of disc 90 is reached, an S-curve and a mirror signal MR are detected. Then, after time  $t_1$  lapses from when the mirror signal MR is detected, at a point of time an in-focus state with respect to disc surface Z2 of disc 90 is reached, an S-curve and a mirror signal MR are detected.

Fig. 9D is a diagram showing a case in which disc 90 is a multi-layer HD disc. In this case, both first and second recording layers L1 and L2 exist in about the middle of disc 90 in the thickness direction. Thus, after time  $t_2$  lapses from when the mirror signal MR is detected, at a point of time an in-focus state with respect to disc surface Z2 of disc 90 is reached, an S-curve and a mirror signal MR are detected twice.

Thus, when disc 90 is mounted as described above, controller 210 moves objective lens 202 like a movement in a focus-search operation. At that time, the timing with which the mirror signal MR and the focus-error signal FE are detected and the number of times the mirror signal MR and the focus-error signal FE are detected are monitored, and the result of the observation can be used to determine whether mounted disc 90 is a single-plate disc, a single-layer HD disc, a hybrid disc, or a multi-layer HD disc.

It is noted that the operation to identify the type of disc 90 can be carried out separately from a focus-search operation. As an alternative, the type of disc 90 may be identified during a focus-search operation.

In addition, the operation to identify the type of disc 90 can also be carried out while objective lens 202 is being lowered.

In an operation to identify the type of disc 90, a laser beam is radiated to disc 90

and information conveyed by a beam reflected by disc 90 is obtained. As a position on disc 90 to which the laser beam is radiated, an inner circumference of disc 90 hardly affected by a skew error is preferable even though an outer circumference may also be used.

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Identification Processing of the Recording and Playback Apparatus and Recording Control Processing of the Memory Card

The following description explains typical processing to identify the type of disc 90 by using the identification technique described above and operations to control recording of data into memory card 1 by memory-card recording and playback unit 27 in recording and playback apparatus 10.

The description begins with an explanation of processing which is carried out by system controller 20 when the user mounts disc 90 onto disc recording and playback unit 25 with reference to a flowchart shown in Fig 10.

Processing represented by the flowchart shown in Fig. 10 is started by system controller 20 when an operation to mount disc 90 through disc insertion unit 13 is detected. As shown in Fig. 10, processing begins with a step F101 at which system controller 20 issues a command to controller 210 of disc recording and playback unit 25 to begin buildup processing. Receiving the command, controller 210 drives servo processor 214 and other components to carry out the following processing.

First, the spindle motor 206 is activated to set the rotation of disc 90 at a CLV or a CAV.

At the same time, semiconductor laser diode 204 starts emitting a laser beam.

In addition, a focus-search operation is executed. At a point in time, objective lens 202 enters a focus lead-in area, the focusing servo is turned on and established.

At the same time, the mirror signal MR is observed as described earlier with reference to Figs. 9A through 9D to determine which one of the 4 types of recording layer structure disc 90 has.

As the focusing servo is set, the tracking servo is established to allow information to be read out from disc 90.

When these pieces of processing are completed, management information of

Then, controller 210 transfers necessary information on the buildup processing, such as disc identification information and information indicating completion of the buildup processing, to system controller 20.

When the user mounts a CD-R by mistake, for example, disc recording and playback unit 25 may not complete the buildup processing properly. This is because semiconductor laser diode 204 outputs, for illustrative purposes, a laser beam having a wavelength of 650 nm. As described earlier, with a laser beam having a wavelength of 650 nm, the CD-R does not respond, and so a recording or playback operation can not be carried out correctly.

It should be noted that the buildup processing cannot be completed properly in some cases because of a scratch on disc 90 or an operation problem of disc recording and playback unit 25 even if the type of disc 90, such as CD-DA or the DVD-ROM, is suitable for recording and playback apparatus 10. In such cases, the error processing is carried out at step F103.

To be more specific, if the outcome of the judgment indicates that disc 90 is not a single-plate disc, the flow of the processing goes on to a step F105 to form a judgment as to whether or not disc 90 is a hybrid disc. If the outcome of the judgment formed at

5 Then, the flow of the processing proceeds to a step F114 at which a recording inhibit flag is turned on. The recording inhibit flag inhibits an operation to record data into memory card 1.

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After disc 90 is determined to be a CD-RW at step F109, the flow of the processing goes on to step F114 at which the recording inhibit flag is turned on.

If the outcome of the judgment formed at step F107 indicates that the reflectance ratio exceeds 50% or the outcome of the judgment formed at step F108 indicates that an  
5 ISRC does not exist, on the other hand, the flow of the processing goes on to a step F110 to form a judgment as to whether disc 90 is a CD-DA or a CD-ROM.

The formation of the judgment at step F110 is based on TOC data read in from disc 90. A type identification code in the TOC data indicates whether disc 90 is a CD-DA or a CD-ROM.

10 If the type identification code acquired from the TOC data indicates that disc 90 is a CD-ROM, the flow of the processing goes on to a step F111 at which disc 90 is determined to be a CD-ROM. Then, the flow of the processing goes on to the step F114 at which the recording inhibit flag is turned on.

If the type identification code acquired from the TOC data indicates that disc 90  
15 is a CD-DA, on the other hand, the flow of the processing goes on to a step F112 at which disc 90 is determined to be a CD-DA. Then, the flow of the processing goes on to a step F113 at which the recording inhibit flag is turned off.

As described above, the recording inhibit flag is turned on or off in dependence on the type of mounted disc 90.

20 The following description explains processing, which is carried out by system controller 20 when a recording command is issued to memory card 1 mounted on memory-card recording and playback unit 27, with reference to a flowchart shown in Fig. 11.

By operating operators 16 and touch panel 17, the user is able to select a source  
25 and record audio data from the selected source into memory card 1. When a command to record audio data into memory card 1 is received, at the first step F201 of the flowchart shown in Fig. 11, system controller 20 identifies which source of the audio data was selected by the user. The selected source is a component selected by source select unit 28.

30 If the selected source is disc 90 undergoing a playback operation in disc recording and playback unit 25, the flow of the processing goes on to a step F202 to

form a judgment as to whether or not the recording inhibit flag has been turned on. The recording inhibit flag is turned on or off when disc 90 is mounted as illustrated in Fig. 10.

As described above, the processing represented by the flowchart shown in Fig. 10 is carried out when disc 90 is mounted. It should be noted, however, that the processing to set the recording inhibit flag based on the identification of the type of disc 90 carried out at step F102 and the subsequent steps can also be performed at a point in time in the flowchart shown in Fig. 11. That is to say, the processing to set the recording inhibit flag can also be carried out when a command to record audio data into memory card 1 is received with disc recording and playback unit 25 selected as a source of the audio data.

As is obvious from the description of the processing represented by the flowchart shown in Fig. 10, if disc 90 is a disk of the DVD type, a CD-ROM or a CD-RW, the recording inhibit flag is turned on. In this case, the flow of the processing goes on from step F202 to a step F207 at which system controller 20 carries out processing to inhibit recording of audio data by memory-card recording and playback unit 27. That is to say, in this case, even if playback data Sd generated by disc recording and playback unit 25 is supplied to memory-card recording and playback unit 27 as data Srec to be recorded, control is executed to prevent memory-card recording and playback unit 27 from recording the data Srec into memory card 1.

From the user's point of view, the operation carried out by the user to start recording audio data into memory card 1 is not accomplished as intended.

If the outcome of the judgment formed at step F202 indicates that the recording inhibit flag has been turned off, that is, if disc 90 is a CD-DA or a hybrid disc (SACD), on the other hand, the flow of the processing goes on to a step F203 to form a judgment as to whether disc 90 is a CD-DA or a hybrid disc (SACD). If disc 90 is a CD-DA, the flow of the processing goes on to a step F206 at which audio data is recorded into memory card 1.

That is to say, memory-card recording and playback unit 27 is controlled so that playback data Sd generated by disc recording and playback unit 25 and supplied to memory-card recording and playback unit 27 as data Srec is recorded into memory card 1 with a timing to start the recording determined by an operation carried out by the user.

If the outcome of the judgment formed at step F203 indicates that disc 90 is a hybrid disc (SACD), on the other hand, the flow of the processing goes on to a step F204 at which a command is issued to disc recording and playback unit 25 to set a playback mode of CD layer. Then, the flow of the processing goes on to step F206 at which audio data is recorded into memory card 1.

That is to say, memory-card recording and playback unit 27 is controlled so that playback data Sd generated by disc recording and playback unit 25 and supplied to memory-card recording and playback unit 27 as data Srec is recorded into memory card 1 with a timing to start the recording determined by an operation carried out by the user.

As described above, audio data is recorded onto the CD layer of the hybrid disc in the same format as the CD-DA.

If cartridge-disc 91 is identified as a source at step F201, on the other hand, the flow of the processing carried out by system controller 20 goes on to a step F205 to form a judgment as to whether or not cartridge-disc 91 mounted on cartridge-disc recording and playback unit 26 is a pre-mastered MD-DA.

The judgment can be formed by reading in type identification data included in TOC data of cartridge-disc 91 (e.g., an MD). That is to say, the judgment can be formed at a point in time cartridge-disc 91 is mounted.

It should be noted that the pre-mastered MD-DA is a playback-only cartridge-disc for storing all management information and all audio data as emboss pits.

On the other hand, the recordable MD-DA is a magneto-optical disc which allows the user to record and play back audio data into and from the disc.

The MD-DATA is also a magneto-optical disc which is a medium for handling data for computer applications.

If the outcome of the judgment formed at step F205 indicates that cartridge-disc 91 is not a pre-mastered MD-DA, that is, if cartridge-disc 91 is a recordable MD-DA or an MD-DATA, the flow of the processing goes on to step F207 at which system controller 20 carries out processing to inhibit recording of audio data by memory-card recording and playback unit 27. That is to say, in this case, even if playback data Smd generated by cartridge-disc recording and playback unit 26 is supplied to memory-card recording and playback unit 27 as data Srec to be recorded, control is executed to prevent memory-card

recording and playback unit 27 from recording the data Srec into memory card 1.

From the user's point of view, the operation carried out by the user to start recording audio data into memory card 1 is not accomplished as intended.

If the outcome of the judgment formed at step F205 indicates that cartridge-disc  
5 91 is a pre-mastered MD-DA, on the other hand, the flow of the processing goes on to step F206 at which audio data is recorded into memory card 1.

That is to say, memory-card recording and playback unit 27 is controlled so that playback data Smd generated by cartridge-disc recording and playback unit 26 and supplied to memory-card recording and playback unit 27 as data Srec is recorded into  
10 memory card 1 with a timing to start the recording determined by an operation carried out by the user.

If the an external input from terminal 21 or AM/FM tuner 24 is identified at step F201 as a source, the flow of the processing goes on to step F207 at which system controller 20 carries out processing to inhibit recording of audio data by the memory-card  
15 recording and playback unit 27. That is to say, in this case, even if external input data Sin or broadcast audio data Stu is supplied to memory-card recording and playback unit 27 as data Srec to be recorded, control is executed to prevent memory-card recording and playback unit 27 from recording the external input data Sin or the broadcast audio data Stu into memory card 1.

20 From the user's point of view, the operation carried out by the user to start recording audio data into memory card 1 is not accomplished as intended.

As described above, in the processing represented by the flowchart shown in Fig. 11, permission and prohibition to dub or record audio data into memory card 1 is controlled.

25 Dubbing from a CD-DA to memory card 1 is permitted. It is noted that a disc for recording text data or picture data, such as CD-TXT and CD-G (CD-Graphic), as sub-code pertains to the CD-DA category.

In addition, dubbing from a hybrid disc (SACD) to memory card 1 is permitted only for data played back from a CD layer. Dubbing from a pre-mastered MD-DA to  
30 memory card 1 is also permitted.

That is to say, in the illustrative embodiment, recording of data from a recording

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5 Dubbing from recording media other than those described above to memory card  
1 is prohibited in accordance with an embodiment of the invention. To be more specific,  
the recording media, the dubbing of data of which is prohibited, are the CD-ROM  
including discs conforming to CD-ROM specifications such as the video CD, the CD-  
RW, the CD-R, the DVD-ROM, the DVD-R, the DVD-RW, the recordable MD-DA and  
10 the MD-DATA.

15 Dubbing of audio data to memory card 1 from AM/FM tuner 24 and terminal 21  
for receiving an external input is also prohibited according to the illustrative embodiment.

In addition, a transmitter can be connected to an external apparatus for playing back data of a recording medium such as a DVD, from which recording of data to memory card 1 is prohibited. The transmitter is then capable of transmitting the playback data to AM/FM tuner 24 employed in recording and playback apparatus 10 typically as an FM wave. By inhibiting the dubbing of audio data to memory card 1 from AM/FM tuner 24, however, it is possible to prevent an operation to record data played back from the recording medium on the external apparatus and transmitted by the transmitter to recording and playback apparatus 10 into memory card 1.

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5           For example, in the illustrative embodiment, recording of data from a recording medium to memory card 1 is permitted provided that the recording medium is a playback-only medium for recording data all as emboss pits, and main data excluding the TOC and management information of sub-codes is audio data only as described above. In this case, a number of conditions for the recording medium are possible.

15 As an alternative, dubbing of data from any recording medium to memory card 1  
may be permitted provided that the data to be recorded is audio data.

As is obvious from the above description, in an operation to record information played back from a first recording medium into a second recording in accordance with the present invention, control is executed to permit or prohibit the operation to record (dub or copy) the information into the second recording medium on the basis of a judgment as to whether the first recording medium is a recording medium with a dubbing operation permitted or prohibited. Thus, the control can be executed to permit or prohibit the operation to copy the information in accordance with the type of the first recording medium, exhibiting an effect of implementability of proper copy management according to types of a variety of recording media, a variety of applications and a variety of data

formats.

In addition, according to the illustrative embodiment, the formation of the judgment as to whether the first recording medium is a recording medium with a dubbing operation permitted or prohibited is based on information conveyed by a beam reflected  
5 from the first recording medium or predetermined identification information recorded on the first recording medium. As a result, the illustrative embodiment is advantageous in that there is no need to provide a special circuit for forming the judgment.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, because certain changes may  
10 be made in carrying out the above method and in the construction(s) set forth without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of  
15 the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therein.

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